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Electric fleets in urban logistics

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Abstract

This paper focuses on electric urban freight mobility by taking into account technical, legal and social factors that are relevant for small and medium-sized cities. It offers an overview of current developments by providing examples of European cities that have successfully introduced electric vehicles into their logistics fleets.

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Keywords: urban logistics; electric fleet; electric wehicles

1. Introduction

The global population is increasingly concentrating in cities. In Europe, around 75% of the population live in urban areas and this is predicted to increase to about 80% by 2020. Our cities and urban areas face many challenges – economic, social, health and environmental. The impacts of cities and urban areas are also felt in other regions which supply cities with food, water and energy, and absorb pollution and waste. However, the proximity of people, businesses and services associated with cities also creates opportunities for improving resource efficiency. Indeed, well designed and well managed urban settings offer great opportunities for sustainable living, and partnerships and coordination from the local to European level can help improve them (The European environment, state and Outlook 2010, urban environment, European Environment Agency).

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2. Urban challenges

Cities are continuously confronted by a variety of challenges caused by the urban transport. On the one hand they have to face the challenges of reducing traffic congestion, CO_2, GHG and pollutant emissions. According to the International Energy Agency (IEA, World Energy Outlook 2008), cities are where 69% of Europe's CO_2 are emitted and urban transport accounts for 70% of the pollutants and 40% of the greenhouse gas emissions from European road transport (Green Paper: Towards a new culture for urban mobility. COM, 2007 551 final. Brussels 25.9.2007). On the other hand, cities have to ensure not only the mobility of citizens, but also urban freight distribution. Cities are continuously addressing the balance between challenges and needs through the application of technologies as well as local policies, and adoption and promotion of specific practices.

Cities in Europe face the challenge of combining competitiveness and sustainable urban development considering the economic and technological changes that have been caused by globalization and the integration process. This challenge has an important impact on issues of urban quality, such as a sustainable mobility, urban transport, and social, economic and environmental conditions. Cities are growing at a rapid pace. This growth is paired with an increase in residential and business needs. With around 80% of the population living in cities, with the majority in medium-sized cities, this has produced an increase in the movement of goods into the city from external producers. Furthermore, 75% of the energy and 75% of CO_2 is consumed in cities. Cities therefore play a key role in achieving the EU objective of 20% energy saving by 2020 and developing a low carbon economy by 2050. The importance and impact of goods movement on the cities suggest that logistics in the city should be a central focus of the evolving transportation network of the city. However, this is not true in most urban contexts since goods movement in cities has largely been forgotten in many urban plans and policies (Hall and Hesse 2013; Dablanc, 2009). Moreover, whenever policies have been passed there is little knowledge on the possible transferability options to other urban contexts or its likelihood of success related to the urban context.

In March 2011, the European Commission published a White Paper (Brussels, 28.3.2011, COM 2011, 144 final) regarding transport. Known as the "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system," it is a strategic document. The White Paper offers evaluation of transport policy in recent years and research results regarding long-term challenges; it also outlines objectives for the upcoming 40 years – until 2050, and it defines specific framework conditions for transportation policy activities for the upcoming 10 years. To achieve a 60% reduction in pollutant emissions from transport in the face of society's growing need for mobility, the White Paper defines the criteria for both transportation policy and progress evaluation. According to them, is recommended the use of halve 'conventionally-fuelled' cars in urban transport by 2030 and removing them completely by 2050.

A study focusing on external costs of transport conducted in 2011 jointly by CE Delft, INFRAS and Fraunhofer ISI shows that external costs are much higher for road transport than for rail transport (External Costs of Transport in Europe, Update Study for 2008, CE Delft, INFRAS, Fraunhofer ISI, Delft, November 2011).

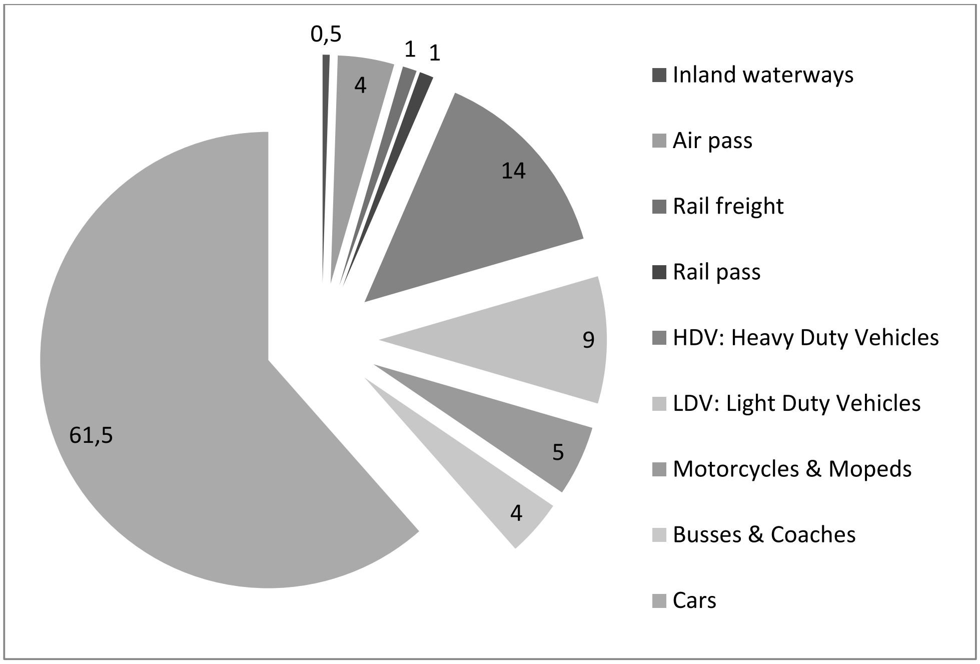

Figure 1 Total external costs of transport by transport mode

Among the means of road transport, the biggest share in external costs of transport belongs to cars (61.5%), which are followed by heavy duty vehicles (14%), light duty vehicles (9%), motorcycles and mopeds (5%) and buses and coaches (4%). Then comes air transport, the share of which in external costs of transport is 4% (only internal EU flights were taken into account). The share of rail transport is just above 1%, and of inland waterway transport – only 0.3%. Sea transport was not considered in the study.

With a share of 35%, accidents dominate in external costs. Congestion and climate change constitute 22% each. The lowest external costs of transport (3%) are related to the noise emitted by vehicles during their operation.

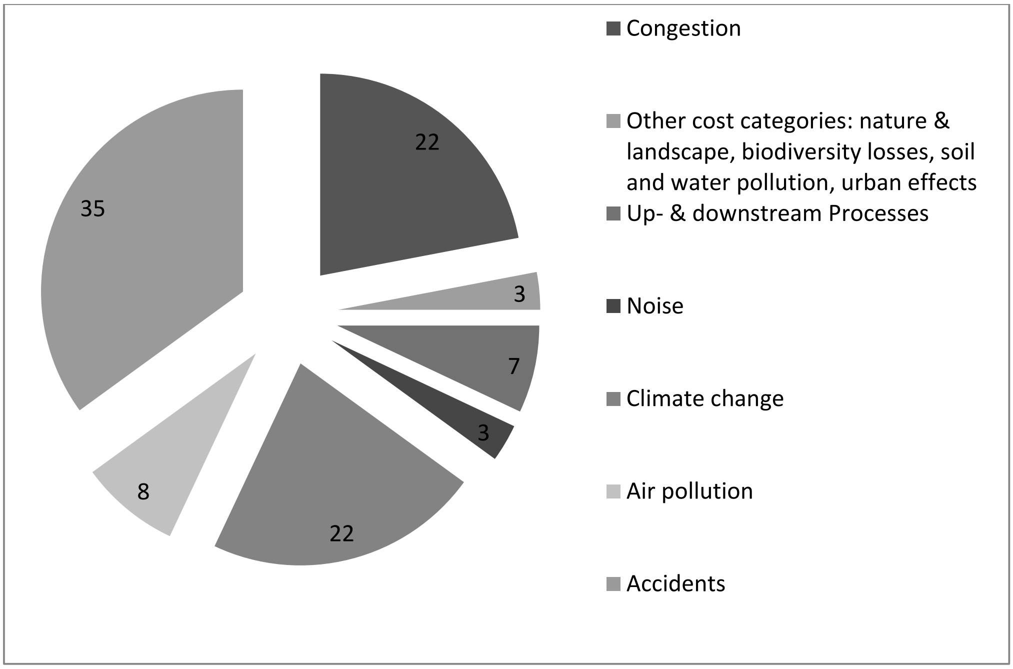

Figure 2 Total external costs of transport by externality

Population growth combined with shifting consumption patterns – such as a rise in online commerce and flexible deliveries – have led to increasing inner and inter urban (freight) transport. Since the year 2000, the total number of global passenger and freight movements has increased by an average of 4%, with global energy usage up by 30%. This increased mobility has many positive effects, but also negative effects on our environment. Transport currently accounts for half of global oil consumption and nearly 20% of world energy usage, of which 40% is utilized in urban transport. Global transport emissions have risen annually by nearly two billion tonnes of CO_2 equivalent since 2000, with freight transport generating between 20% and 60% of local transport-based pollution (International Energy Agency, World Energy Outlook 2013). Despite a substantial decrease in emissions of many air pollutants in Europe over past decades, air pollutant concentrations are still too high, with around 90% of city dwellers exposed to damaging air pollutants at levels deemed harmful to health by the World Health Organization (European Environment Agency, 2013).

Due to their particular architecture, small and medium-sized historic towns are particularly affected by these developments. They suffer from the elevated noise and air pollution, congestion and health and safety issues which result from more urban freight transport entering historic city centers. It is imperative that feasible and sustainable urban logistics solutions are found that result in tangible reductions in energy consumption and environmental impacts. This is the focus of ENCLOSE project – Energy Efficiency in City Logistics for Small and Mid-Sized European Historic Towns.

3. Background and aim of ENCLOSE Project

The goal of the ENCLOSE Project (www.enclose.eu) is raising awareness about the challenges of energy efficient and sustainable urban logistics in European Small-/Mid-size Historic Towns (SMHTs) and about the concrete opportunities to achieve highly significant improvements and benefits by implementing and operating suitable and effective measures, schemes and framework approaches specifically targeted to such class of urban environments.

In fact, whilst efforts and city logistics innovation projects have been undertaken in most European capital and major cities, small and mid-size towns, particularly those involving historic centers, are somehow lagging behind, as they have to face and overcome several barriers (related to e.g. shortage of resources, competences, organizational structures, institutional backing, etc.) to be able to effectively embrace innovation, adopt and implement appropriate plans and measures towards sustainable city logistics. They also have additional constraints and challenges related to their specific territorial, social and economic characteristics (e.g. difficult mobility and freight distribution flows, higher impacts of environmental pollution on citizens and quality of life, etc.) and yet show increasing demand of effective measures as well as large potentials for improvements of energy efficiency and sustainability of city logistics operations.

The ENCLOSE project addresses the urban energy-efficient transport theme particularly from the following angles:

(i) addressing the specific needs, requirements, options and priorities of European small-/mid-size historic towns, demonstrating and assessing feasible and sustainable solutions leading to tangible and measurable changes in behavior and impacts of logistics, and transferring best practice and benefits within and beyond the network of participating towns,
(ii) qualifying the demand of Local Authorities and municipalities of European SMHTs for sustainable, energy efficient urban logistics and freight distribution solutions, generating and spreading the knowledge about good practices and suitable strategies for effective integration of freight distribution and logistics schemes in the overall urban mobility and, more generally, town governance policies;
(iii) investigating and assessing the operation of "green vehicles" (FEVs, PHEVs, Bio-gas) and fleets in urban distribution and other logistics schemes from the point of view of the needs and requirements of in small /mid-size historic towns, assessing the full energy cycle and impacts, identifying their additional benefits and key issues for any effective adoption and integration in the overall logistics, mobility and energy management plans.

To this end, the ENCLOSE project will support the development of Sustainable Urban Logistic Plans (SULP) in European small/mid-size historic towns (SMHT) involving 16 partners from 13 EU countries – Austria, Bulgaria, Greece, Ireland, Italy, Norway, Poland, Portugal, Rumania, Spain, Sweden, Netherlands and United Kingdom, also providing the necessary multiplying promotion and diffusion.

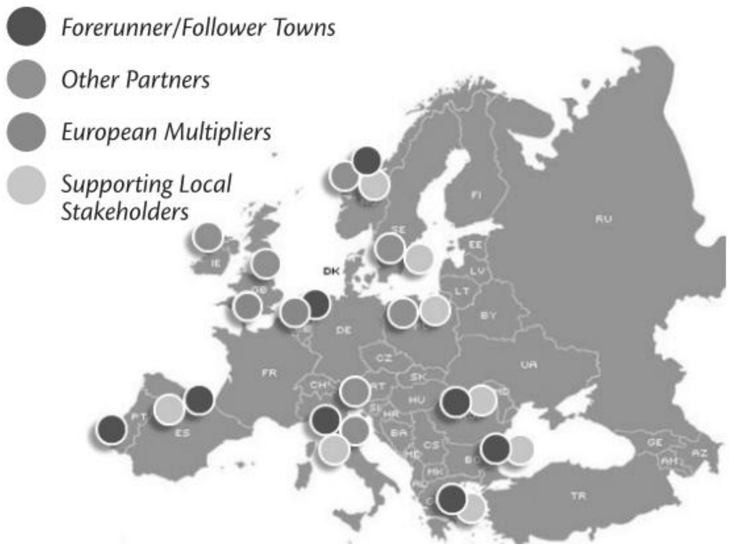

Figure 3. Project ENCLOSE partners

The major objectives and expected results of the ENCLOSE project can be summarized as follows:

(i) Assess the applicability and benefits of energy-efficient and sustainable urban logistics measures specifically targeted to European SMHTs, by implementation of i) Pilot Operations in 3 forerunner towns (in Italy, Norway and The Netherlands) and ii) Feasibility and Transferability analysis and implementation of soft measures carried out in 6 follower towns in Bulgaria, Greece, Portugal, Rumania, Spain and UK.

(ii) Development of Sustainable Urban Logistic Plans (SULPs) in the 9 ENCLOSE towns. Aiming to achieve an early propagation effect within the project life time, the local administrations of the ENCLOSE towns (pilots and followers) will adopt their respective specific SULP. The SULPs will be developed with participatory approach, in order to reach a strong consensus among the relevant stakeholders and to consider the foreseen logistics measures in the overall urban mobility policy in order to increase the energy efficiency of the freight distribution in the urban centers.

(iii) Building up a suitable and usable framework for the definition of SULPs for SMHTs. This will lead to a key usable tool for European towns, decision makers and urban logistics stakeholders. Linking to the concept and guidelines, a general framework will be produced which will guide and enable European SMHTs to set up their SULPs, with a clear definition of energy-efficiency in city logistics processes. The SULPs implementation, as well as massive replication of assessed ENCLOSE solutions, will contribute to significant reduction of energy and environmental impacts in European SMHTs.

(iv) Investigating policy-level issues and defining a suitable strategy to ensure long-term sustainability of the designed SULPs framework for SMHTs. In order to foster long term impacts of the project, complementary to the SULPs framework for local authorities and logistics stakeholders, ENCLOSE will provide elements to address and stimulate the various institutional levels (regional, national, EU) to ensure the necessary frame conditions (i.e. legislative, normative, incentive, etc.) for the adoption and implementation of the SULPs by the concerned towns.

(v) Promoting and enhancing the networking of European SMHTs on the themes of sustainable and energy efficient logistics, to facilitate the exchange of experiences, promote and achieve the adoption of SULPs. The aim is to enable SMHTs logistics decision makers and stakeholders to fully understand the opportunities for and introduce energy-efficient and sustainable city logistics solutions in their environment.

4. Electric vehicles in urban logistics

Electric vehicles are an energy-efficient alternative in inner-city traffic with frequent stops and can mitigate some of the problems caused by urban freight transport. Shifting inner-city distribution from conventionally-fuelled to electric vehicles helps to reduce emissions and noise. The advantages of electric vehicles are even more pronounced when switching to more efficient ways for the last-mile delivery of goods in city centers.
Table 1 shows the types of electric vehicles.

Table 1. Types of electric vehicles.

Acronym	Description
EV OR BEV	All-electric or battery electric vehicles are powered only by one or more electric motors. They receive electricity by plugging into the grid and storing it in batteries. They consume no petroleum-based fuel while driving and produce no tailpipe emissions.
PHEVS	Plug-in hybrid electric vehicles use batteries to power an electric motor, plug into the electric grid to charge, and use a petroleum-based or alternative fuel to power an ICE or other propulsion source.
HEVS	Hybrid electric vehicles combine an ICE or other propulsion source with batteries, regenerative braking, and an electric motor to provide high fuel economy. They rely on a petroleum-based or alternative fuel for power and are not plugged in to charge. HEV batteries are charged by the ICE or other propulsion source and during regenerative braking.
ICE	Internal combustion engines generate mechanical power by burning a liquid fuel (such as gasoline, diesel, or biofuels) or a gaseous fuel (such as compressed natural gas). They are the dominant power source used by on-road vehicles today.
EVSE	Electric vehicle supply equipment delivers electrical energy from an electricity source to charge an EV's or PHEV's batteries. It communicates with the EV/PHEV to ensure that an appropriate and safe flow of electricity is supplied.

Electric vehicles, whether purely electric, plug-in or hybrid (see Table 1 for definitions), face a number of market barriers relating to:

(i) range (100-150 km),
(ii) charging time (typically 6-8 hours for a full charge),
(iii) insufficient charging infrastructure network,
(iv) to high investment costs (compared to conventional vehicles),
(v) lacking or inadequate incentives,
(vi) lack of information, and
(vii) disinformation and misinformation.

Figure 4. Examples of cargo electric cars

5. LuccaPort – Urban Consolidation Center

A widely adopted practice to tackle the “last mile” distribution problem is the establishment of Urban Consolidation Centres (UCC). An UCC is a logistics facility for the last mile collection and distribution of goods which is situated close to the urban area that it serves. UCCs are used by large freight transport service providers for operational purposes near cities, functioning as a junction between urban and interurban parts of the transport chain. The main freight operations carried out in UCCs are:

(i) handling of cargo,
(ii) loading and unloading,
(iii) warehousing, and
(iv) added value services.

The town of Lucca has a population of about 80,000 inhabitants and an area of just over 185 square km with an average density of about 430 inhabitants per square kilometre. The core of the city is surrounded by Renaissance walls, the most representative monument of the city, extending for about 4.2 km, interspersed with a series of ramparts. Access to the centre is through six ports located along the walls that connect the external road network with internal reticule of medieval style.

The historic centre in Lucca and surrounding areas actually represent the core of an active commercial system with more than 1400 activities with great variety commercials, artisans' and professionals' activities. Moreover the offices of main public authorities are localized in the historic city centre. This active economic context contributes to the high number of commercial vehicles for freight distribution acceding to the historic city centre per day, bringing to the subsequent negative impacts, both directly and indirectly on the urban environment due to air and noise pollution and traffic congestion especially in the rush hours.

In the historic centre, strongly affected by the road and access structures, integrated traffic regulations are in force including Restricted Traffic Zone (RTZ) and Pedestrian Zone (PD) and with a maximum speed limit of 30 kilometres per hour for all vehicles. Vehicle access permission is granted to residents, traders present with their activities in the center, freight vehicles for the delivery service, tourists travelling to the hotels. Freights transport vehicles are allowed during an access window from 7.00 to 10.00 and from 14.30 to 15.30 with up to maximum loaded mass of 3.5 tons and maximum dimensions of 5.40m long, 2m wide and 2.10m in height (limits derogated only in special cases). Recently a survey, confirmed by studies produced by the Chamber of Commerce of Lucca, identify in this area about 1500 showcase fronts corresponding to more than 1400 shops or artisan laboratories that implies large amounts of delivered goods. Approximately 1,300 vehicles per day have access to the historical centre in the time slot 8-20. The peak of about 200 vehicle entries is between 8.00 and 9.00 and more than 56% of the vehicles access is concentrated in the morning from 8 to 12 with considerable trouble for the flow of pedestrian citizen and tourist. The analysis of data collected in the survey shows that on average the main flows of delivered goods in the study area are represented by 15% alimentary products, 12% clothing and sports, 7% furniture, 12% electronic equipment, 7%, pharmaceuticals, 15% cars and mechanics. About 27% of the shops are using own vehicle and the rest are served by couriers and transport operators. Regardless of the type of vehicles used almost all consist of vans and trucks with diesel engines. From interviews results that the average load factor of the freight transport vehicles is no more than 40%.

The key Lucca logistic infrastructure is the Urban Consolidation Center providing the services to support "last mile" deliveries to Lucca centre within the wider scale regional (and national) freight logistics chains. In that, LuccaPort provides all typical UCC services to support cooperation between long-/mid-range freight operators and the local distribution actors including: transhipment of goods at the LuccaPort logistic platform; organization of best possible operations (e.g. groupage, load consolidation, etc.) for deliveries of goods to their final destinations.

Figure 5. Luccaport – urban consolidation center

Beginning in 2005, the urban logistics service was improved and it is actually operating using a dedicated warehouse, a fleet of full electric vehicles and a innovative ICT services enabling the exchange of updated information – including particularly track-and-trace information – between the transport operators utilizing Lucca Port delivery services, the Lucca Port itself and all the actors throughout the logistics service chain.

Luccaport is being able to make more than 120 daily deliveries (average 4/5 parcels/consigns, 2,5 teu/gg.) working with 100% load factor and making about 15 deliveries every trip, corresponding to 15% of city deliveries and allowing a reduction in the number of commercial vehicles accessing the historic centre of 44% . The Eco-friendly goods distribution system promoted by the Municipality of Lucca was mainly developed under national and EU funds and it has led to Lucca becoming a reference model for Toscana Region policy framework.

Figure 6. Luccaport – electric vehicles

6. Posten Norge – post distribution in Trondheim

Trondheim is the Norway's most known historic town with a population of about 180 000 inhabitants, it is the third most populous municipality in Norway and city in the country.

The area in the inner city of Trondheim is about 1 km^2 and includes the historic city, as well as commercial activities, institutions and some dwelling areas (6134 households, offices and stores). The central area is delineated by the river Nid in the south and east, and by the canal in the north. The city centre is accessible by four main routes, from the south, west, east and north. The traffic amounts to around 75 - 80 000 vehicles travelling daily to or from the centre. This includes more than 2 000 bus trips, as this is the hub of the public transport system. The modal split of people actually accessing to the city centre is as follow:

(i) Private car (driver) 25%,
(ii) Private car (passenger) 8%,
(iii) Public transport 16%,
(iv) Cycling 10%, and
(v) Walking 40%.

A deep analysis and statistics about infrastructure and facilities for freight transport and distribution in Trondheim is still lacking, however it is estimated that about 10% of heavy vehicle (> 3 500 kilograms) distribution in Trondheim is connected to the inner city. In the central areas, smaller vehicles carry out an important part of the deliveries as well. Moreover, the harbor and the rail freight terminal are located in the north side of the city centre, while several large freight terminals are situated 4-12 km south of the centre.

To date an optimized service of goods distribution is operating in the city and it is managed by the company Posten Norge, that in addition to the mail distribution, operates in the logistic sector with 7 terminals and a large commercial vehicle fleet. Posten Norge uses a warehouse located 5 km south of Trondheim and employs almost all fully electric vehicles for freight distribution. The Norway Post group is a significant post and logistics provider with Mail and Logistics as main business areas. Norway Post is fully owned by the Norwegian state, but operate as an ordinary private transport actor with the Nordic countries as the home market. Norway Post has environment as a Common Social Responsible area, and have decided to take the position as the leading transport company on environment in Scandinavia. Norway Post has ambitious goals for reduced CO_2 emissions which is 30 % reduction in 2015 from 2008-level.

When the project “CO2-free post distribution in Trondheim city center” started in March 2010, this service was done by 5 postmen who each operate from a diesel van (Peugeot Partner). The logistics solution was that early each morning 6 days a week the 5 postmen started their work at the Trondheim Post Terminal. After finished their route planning activities the letters were uploaded in 5 vans and the 5 postmen drove into the city center for the mail delivery. Each postman had their own route in the city center, and they organized the Mail delivery by parking the vehicle and walking in the nearby area for delivery in mail boxes and partly on desks in the shops. After finishing a part of a route they drove the car to next stop and the same activity was done.

The project decided to establish an UCC (Urban Consolidation Center) in the city center in Trondheim. The project also decided to start replacing the diesel cars with electric vehicles like trolleys, bicycles or mopeds to reduce CO2-emissions. For this pilot measure the goal was to reduce the CO2-emissions to zero. It was also a goal to reduce costs by reducing the postmen driving time between the Post Terminal and the city center. With a UCC inside the city center the plan was to have the postmen to meet directly at the UCC instead of at the Post Terminal.

Figure 7. Poste Norge – electric vehicles

7. 's-Hertogenbosch

's-Hertogenbosch (short: Den Bosch), is a city in southern Netherlands. Located 80 km south of Amsterdam, it is the capital of the province of North Brabant with a rich culture history. The city has 140,000 inhabitants, 100,000 of them working in various sectors in 9,890 companies, with a particular focus on food, healthcare and pharmaceutics. A considerable activity is also tourism with the presence of 5,200,000 annual visitors.

The 's-Hertogenbosch study area is the historical center, with triangle shape surrounded by canals. The city of 's-Hertogenbosch has undertaken many efforts to reduce private cars traffic and at the present a large sector of the historic inner city is closed for private motorized traffic. Motorized transport accounts for about 30% of the CO_2 emissions in the city and is the main cause of air quality problems. Moreover, the Municipality of Den Bosch has developed several measures to reach the set target, e.g. increasing the environmental zone, the greening of municipal fleet, urban goods distribution, clean public transport, environmentally parking places, green structures, transport management, bicycle plan, extension, dynamic traffic and Bio gas. There is also an environmental zone where only clean trucks are allowed. Mobility measures encourage people to use bicycles and the public transport. Several commercial activities are located in the city centre. In the area there are 550 retailers (72%) and 220 in HORECA (28%). Retailers (94,000 m^2) are mainly “fashion & luxery” (58 %). HORECA consists mainly of bars & restaurants (70%). ‘s-Hertogenbosch has analysed the actual situation concerning freight distribution and mobility in the city centre: 5,000 m^3 of freight is delivered each week by means of 5,000 deliveries and approximately 2,500 rides. Each shop receives an average of 5 to 10 deliveries. Around 50% of the deliveries are combined. Further traffic in the inner city is mainly related to garbage collection, building and maintenance, public transport (shopping included).

On the basis of the operational background and local context described above, s’Hertogenbosch is focusing on delivery as well as other municipal logistics services and piloting actions such us demonstrating and enhancing the use of fully electric busses for transport of people with bulky purchases. From 2015 all public transport will be diverted and all lines will use and stop only on the ring around the city centre. Due to the limited size of the city centre the last kilometre can be done by walking. An additional service with three small electric buses has been tested and is planned mainly for tourists and elderly people. The only full sized (12 meter) buses that will continue to enter the city centre, will be the P&R shuttles. This concept will make that all remaining public transport in the city centre runs on zero emissions. This means a significant reduction in noise, vibrations and emissions and so improvement of air quality, attractiveness and sustainability.

The existing electric mini-buses in 's-Hertogenbosch charge at night. For them, overnight charging is sufficient for a days schedule. Big 12 metre buses would demand much more battery-capacity. This would make them heavy and expensive. By recharging while in service, less batteries are required but still guarantee operation from early morning until late evening. In practice the bus receives a fast and powerful recharge while boarding passengers at the bus stop – Inductive Power Transfer, an energy transmission system for electric vehicles, which works by magnetic resonance coupling. This way the recharging has been fitted into the existing timetable.

Figure 8. 's-Hertogenbosch – electric buses

8. Conclusions

Many European cities, including small and medium-sized towns, have started greening freight transport over the past couple of years as part of an impressive number of projects under the initiative similar to the ENCLOSE project. The introduction of cleaner fuels and vehicles leads to a reduction in greenhouse gas emissions and local air pollution. However, it is clear that any such initiative needs to be part of a municipality's overall mobility strategy.

Especially in the case of smaller cities, regional approaches and partnerships with local associations and stakeholders are extremely important. When it comes to electric vehicles, specific technology choices should not be the sole focus of greening urban freight. Rather, a green vehicle strategy should be part of a broader initiative towards sustainable urban freight transport. It is especially important to develop a fleet planning initiative, consider available financing and the purchase of tools, and reallocate resources. Lastly, the total cost of ownership, including the resale value of vehicles, and the lower maintenance costs need to be taken into consideration.

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